EDM User Manual

Educational Data Mining Workbench Manual V3.5

Content

Revision History

Name	Date	Reason For Changes	Version
John Paul Contillo	20111121	First draft	V1.00
Alipio Gabriel	20111122	Edit the context of the draft	V1.00
Alipio Gabriel	20111123	Add and edit the content	V1.00

J.Contillo	20120221	User manual for version 2	V2.00
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Introduction

In recent years, educational data mining methods have afforded the development of detectors of a range of constructs of educational importance, from gaming the system [3] to off-task behaviour [2] to motivation [5] to collaboration and argumentation moves [6]. The development of these detectors has been supported by the availability of machine learning packages such as RapidMiner [7], WEKA [9], and KEEL [1]. These packages provide large numbers of algorithms of general use, reducing the need for implementing algorithms locally, however they do not provide algorithms specialized for educational data mining, such as the widely used Bayesian Knowledge-Tracing [4]. Furthermore, effective use of these packages by the educational research and practice communities presumes that key steps in the educational data mining process have already been completed. For example, many of these detectors have been developed using supervised learning methods, which require that labelled instances, indicative of the categories of interest, be provided. Typically, many labelled instances – on the order of hundreds, if not thousands – are required to create a reliable behaviour detector. Labelling data is a time consuming and laborious task, made even more difficult by the lack of tools available to support it.

A second challenge is the engineering and distillation of relevant and appropriate data features for use in detector development [9]. The data that is directly available from log files typically lacks key information needed for optimal machine-learned models. For instance, the gaming detectors of both [3] and [8] rely upon assessments of how much faster or slower a specific action is than the average across all students on a problem step, as well as assessments of the probability that the student knew the cognitive skills used in the current problem step. This information can be distilled and/or calculated by processing data across an entire log file corpus, but there are currently no standard tools to accomplish this. Feature distillation is time-consuming, and many times a research group re-

uses the same feature set and feature distillation software across several projects (the second author, for instance, has been using variants of the same feature set within Cognitive Tutors for nine years). Developing appropriate features can be a major challenge to new entrants in this research area. To address this "data labeling bottleneck" and the difficulty in distilling relevant features for machine learning, we are developing an *Educational Data Mining (EDM) Workbench*. A beta version of this Workbench, now available online at http://penoy.admu.edu.ph/~alls/downloads, is described in this user manual. The Workbench currently allows learning scientists to:

1) Label previously collected educational log data with behaviour categories of interest (e.g. gaming the system, help avoidance), considerably faster than is possible through previous live observation or existing data labelling methods.
2) Collaborate with others in labelling data.
3) Automatically distil additional information from log files for use in machine learning, such as estimates of student knowledge and context about student response time (i.e. how much faster or slower was the student's action than the average for that problem step).

Through the use of this tool, we hope that the process of developing a detector of relevant metacognitive, motivational, engagement, or collaborative behaviours can eventually be sped up. Just the use of "text replays", on previously collected log data has been shown to speed a key phase of detector development by about 40 times, with no reduction in detector goodness [3].

This user manual is intended as a guide to the functions and features of the EDM Workbench. Please send comments and suggestions to mrodrigo@ateneo.edu.

Definition of Terms

Batch

A group of log files. The criteria for grouping are determined by the user. Examples of the criteria for grouping include source and timing

Clip

A subset of logs from a given batch

Column

A single attribute within the dataset

Dataset

The data from the imported files

DataGrid

The central area where all the datasets are displayed.

EDM

Educational Data Mining

Log

A record of a single action

Log File

A file that contains a collection of logs

Model

A detector of meta-cognitive and motivational behaviour

Row

A set of attributes in the dataset that usually refers to 1 log

Interface

Refers to the system graphical user interface

Overall Description

The EDM Workbench is a tool that helps researchers with processing data from various sources for developing meta-cognitive and behavioural models. The concept diagram in figure 1 illustrates the system functionalities and entities interacting with it.

The EDM Workbench's functions allow users to:

- Define and modify behaviour categories of interest
- Label previously collected educational log data with the categories of interest considerably faster than current methods
- Collaborate with others in Labelling data by providing ways to communicate and document Labelling guidelines and standards
- Validate inter-rater reliability between multiple labellers of the same educational log data corpus
- Automatically distil additional information from log files for use in machine learning
- Export student behaviour data to tools which enable sophisticated secondary analysis

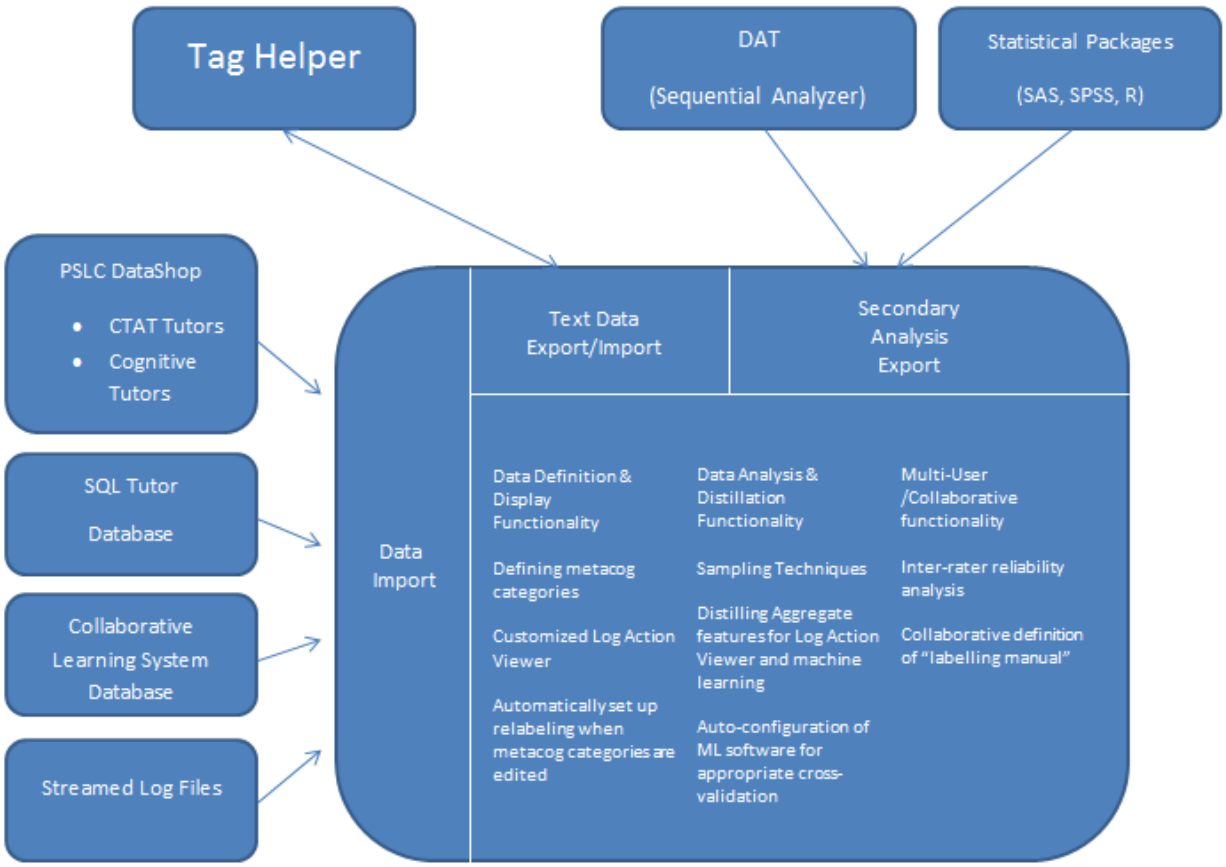


Figure 1: EDM Workbench Entity Diagram

Overall Use Cases

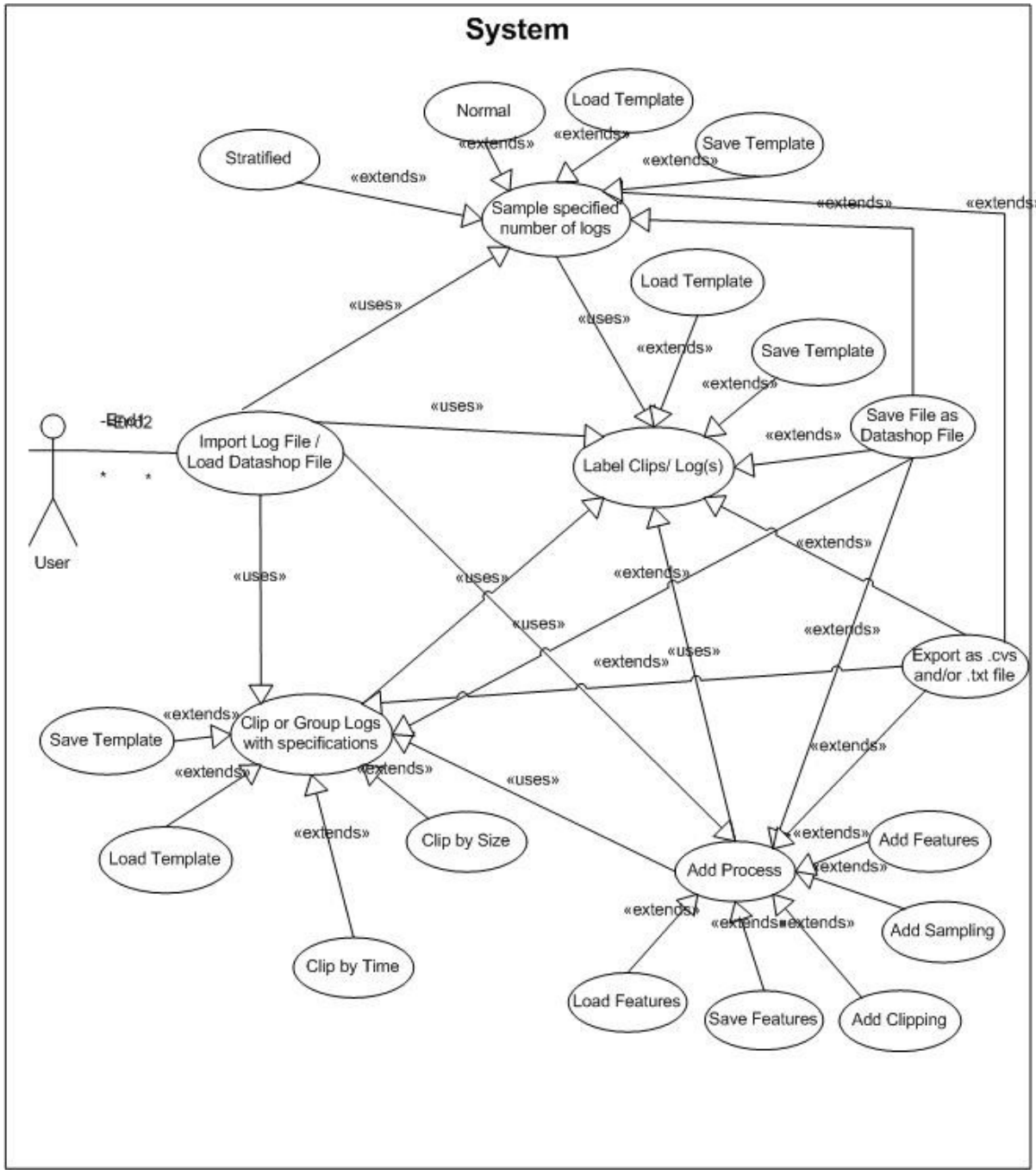


Figure 2: EDM System Process Map

Chapter 1. System Overview

This section, discusses the interface of the system (from Top to Bottom) including its features, buttons, and functions.

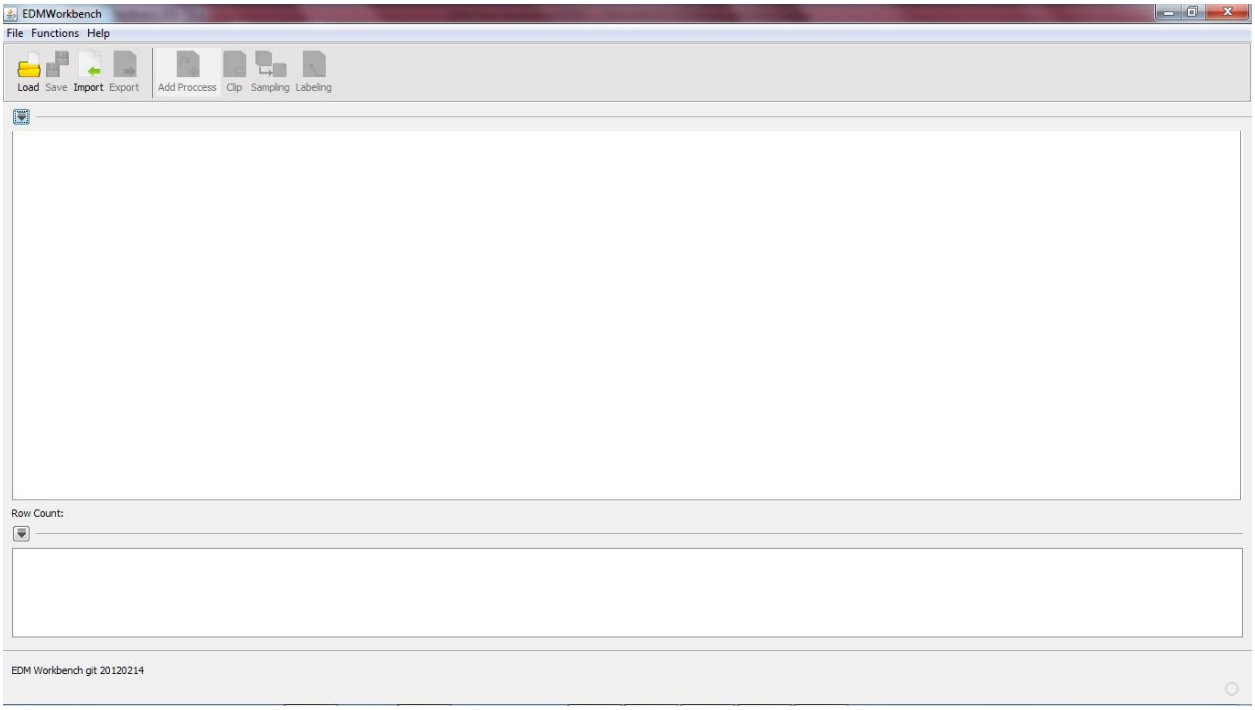


Figure 3: EDM workbench upon system launch

Title Bar

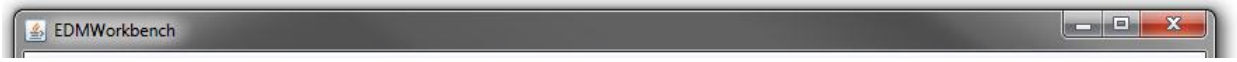


Figure 4: System Title Bar

The name of the system (may change in later versions e.g. EDM Workbench version 3.5) is displayed here.

- ## Menu Bar

- Figure 5: EDM Menu Bar

Composed of 3 Menu options (File, Functions, and Help) consisting of actions buttons.

- ### File Menu

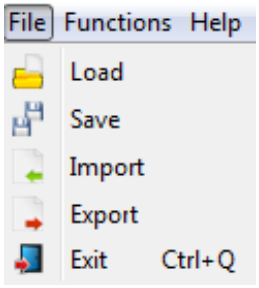


Figure 6: File Menu Dropdown

The **File Menu** is composed of 5 actions (Load, Save, Import, Export and Exit) that handle the files and logs to be displayed and/ or saved in the DataGrid.

○ Function Menu

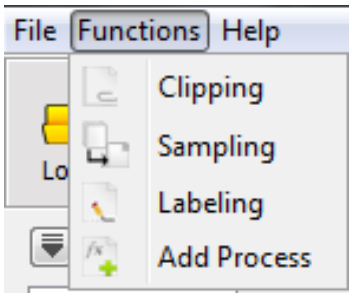


Figure 7: EDM Function menu Dropdown

The **Function Menu** consists of 4 log processing actions that will either be enabled or disabled depending on the state of the system.

○ Help Menu

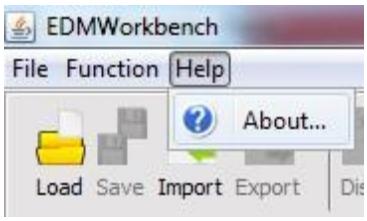


Figure 8: EDM Help Menu showing the About button

The **Help Menu** contains the "About" action that displays the system description and the current product version (e.g. 20120227).

▪ Tool Bar

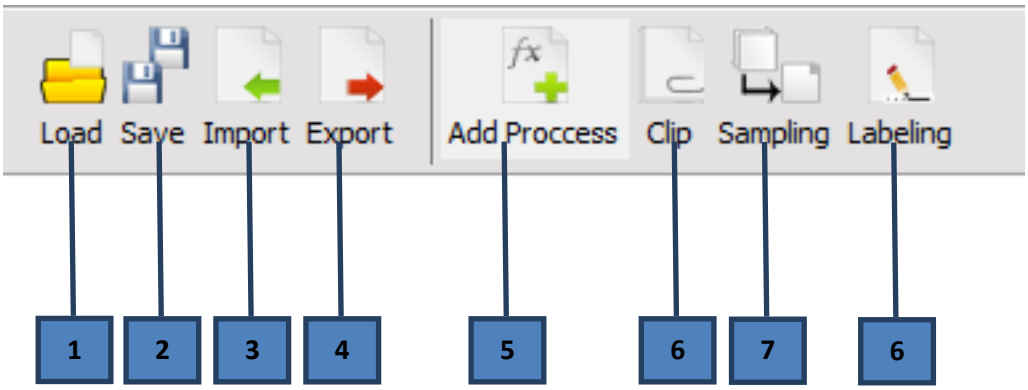


Figure 9: EDM Toolbar with activated buttons

The **Tool bar** is composed of action buttons that are also found in the menu bar for ease of use.

1. Load Button

Loads log files which were previously saved using the EDM Workbench and stored in an EDM Workbench-specific.zip file. The file contains logs that may have been previously processed, clipped, sampled, or labelled by the user together with some Workbench-specific information. Note that, because of the additional information, the zip file may not be opened using archiving software such as WinZip or WinRar. Once loaded, the user may make further changes to the file.

2. Save Button

Saves the logs from the active tab in the DataGrid and all its properties such as clipped formats and labels into EDM format.

3. Import Button

Allows the user to import logs or batches of logs such as Datashop or comma-separated value(.csv files) to be processed, clipped, sample or labelled by the user.

4. Export Button

Exports the final output from the active tab in the DataGrid as a .csv file or in other specified file formats.

5. Add Process Button

Allows the user to add and possibly save an action to a sequence of actions

6. Clip Button

Groups logs from a given batch based on user-specified parameters.

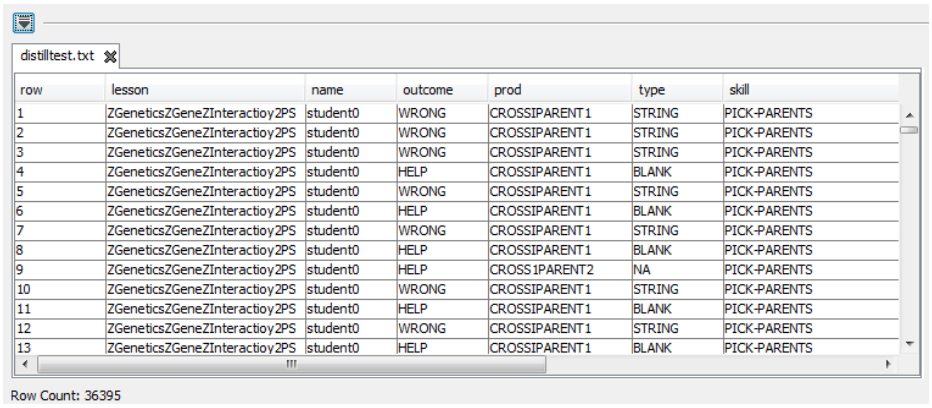
7. Sampling Button

Selects rows from the dataset based on user parameters.

8. Labelling Button

Allows the user to supply “ground truth” labels for clip

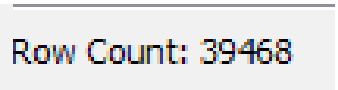
▪ DataGrid



row	lesson	name	outcome	prod	type	skill
1	ZGeneticsZGeneZInteractioy2PS	student0	WRONG	CROSSIPARENT1	STRING	PICK-PARENTS
2	ZGeneticsZGeneZInteractioy2PS	student0	WRONG	CROSSIPARENT1	STRING	PICK-PARENTS
3	ZGeneticsZGeneZInteractioy2PS	student0	WRONG	CROSSIPARENT1	STRING	PICK-PARENTS
4	ZGeneticsZGeneZInteractioy2PS	student0	HELP	CROSSIPARENT1	BLANK	PICK-PARENTS
5	ZGeneticsZGeneZInteractioy2PS	student0	WRONG	CROSSIPARENT1	STRING	PICK-PARENTS
6	ZGeneticsZGeneZInteractioy2PS	student0	HELP	CROSSIPARENT1	BLANK	PICK-PARENTS
7	ZGeneticsZGeneZInteractioy2PS	student0	WRONG	CROSSIPARENT1	STRING	PICK-PARENTS
8	ZGeneticsZGeneZInteractioy2PS	student0	HELP	CROSSIPARENT1	BLANK	PICK-PARENTS
9	ZGeneticsZGeneZInteractioy2PS	student0	HELP	CROSS1PARENT2	NA	PICK-PARENTS
10	ZGeneticsZGeneZInteractioy2PS	student0	WRONG	CROSSIPARENT1	STRING	PICK-PARENTS
11	ZGeneticsZGeneZInteractioy2PS	student0	HELP	CROSSIPARENT1	BLANK	PICK-PARENTS
12	ZGeneticsZGeneZInteractioy2PS	student0	WRONG	CROSSIPARENT1	STRING	PICK-PARENTS
13	ZGeneticsZGeneZInteractioy2PS	student0	HELP	CROSSIPARENT1	BLANK	PICK-PARENTS

Figure 10: EDM DataGrid

The **DataGrid** displays the logs that are active and are to be processed. The downarrow button hides the data grid.



Row Count controls the amount of rows shown in the active tab

▪ Status Bar

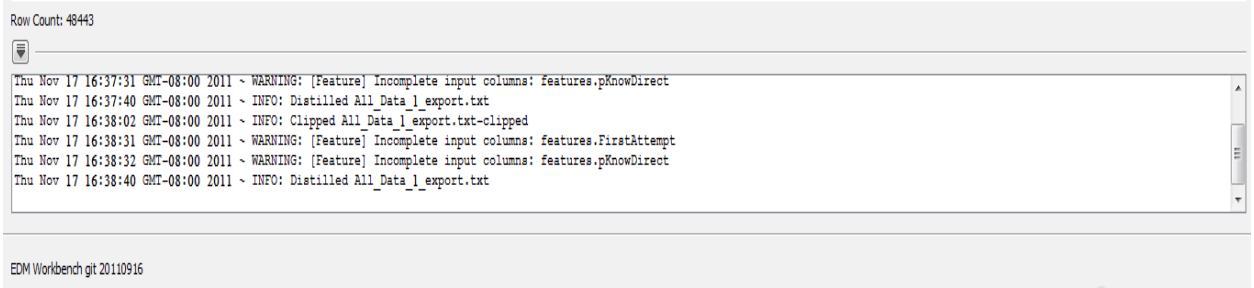


Figure 11: System Status Bar with sample error messages

The **Status Bar** displays feedback information such as status, error messages, time elapsed and others.

Chapter 2. System Manual

Import

The EDM Workbench allows users to import logs in DataShop text format and CSV. The data is assumed to be stored in a flat file, organized in rows and columns. The first row of the import file is assumed to contain each column's name. Each succeeding row represents one logged transaction, usually between the student and tutor but possibly between two or more students as in the case of collaborative learning scenarios. The successfully-imported logs may be saved in the Workbench's format for work files—a compressed file containing the data in CSV format plus metadata specific to the EDM Workbench.

Import log file by clicking Import Button 

located either in File menu (Figure 6) or Toolbar (Figure 9). The system will then pop-up a dialog box asking what type of logs you want to import (CSV or Datashop Text file Figure 12). Click the Select Button after selecting the type of Log.

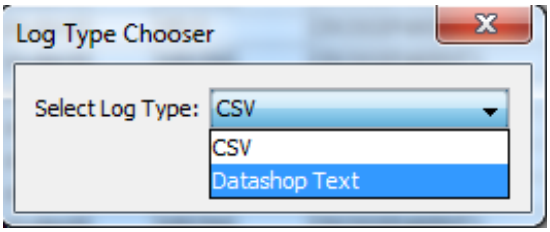


Figure 12: Log Selection

Another dialog box will ask for the location of the log file.

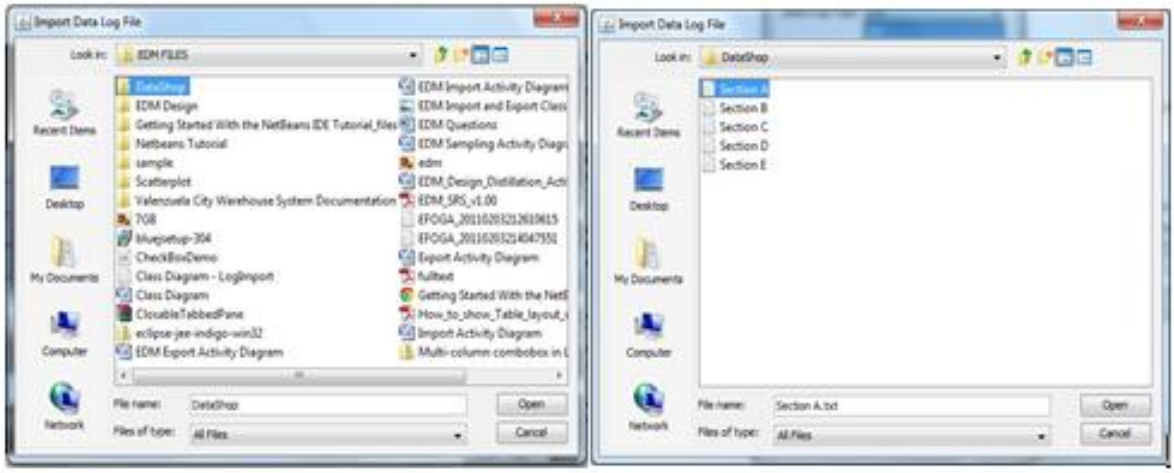


Figure 13: Selection of Data File to be imported

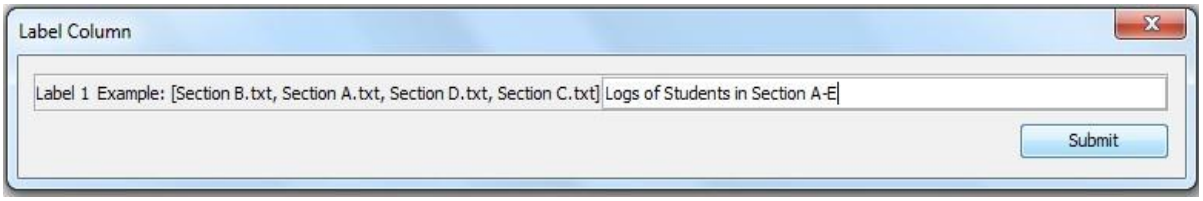
Case 1: Importing a single log file

If a user imports a single log file after locating and choosing the log file, the Workbench displays the file in the DataGrid (Figure 10).

Case 2: Importing batches of log files

The Workbench can also import nested folders of data, where each folder level represents a meaningful subset of the data. For example, if data from a section of students is collected several times over a school year, the researcher may have one folder for the school year, one subfolder for each section within the school year, one subfolder for a session within each section, and finally one file or folder for each student within a session. The Workbench allows users to label each level of subfolder, creating new columns for these labels, appending them to the data tables during importation process.

After locating and choosing the batch of log files another dialog box will appear asking for a label describing the log files imported (e.g Class) (Figure 13). Clicking Submit aggregates all the logs and displays them in the DataGrid.



Once the logs are loaded, the DataGrid should be populated (Figure 15). All actions buttons, save for the Labelling button, should be enabled at this point.

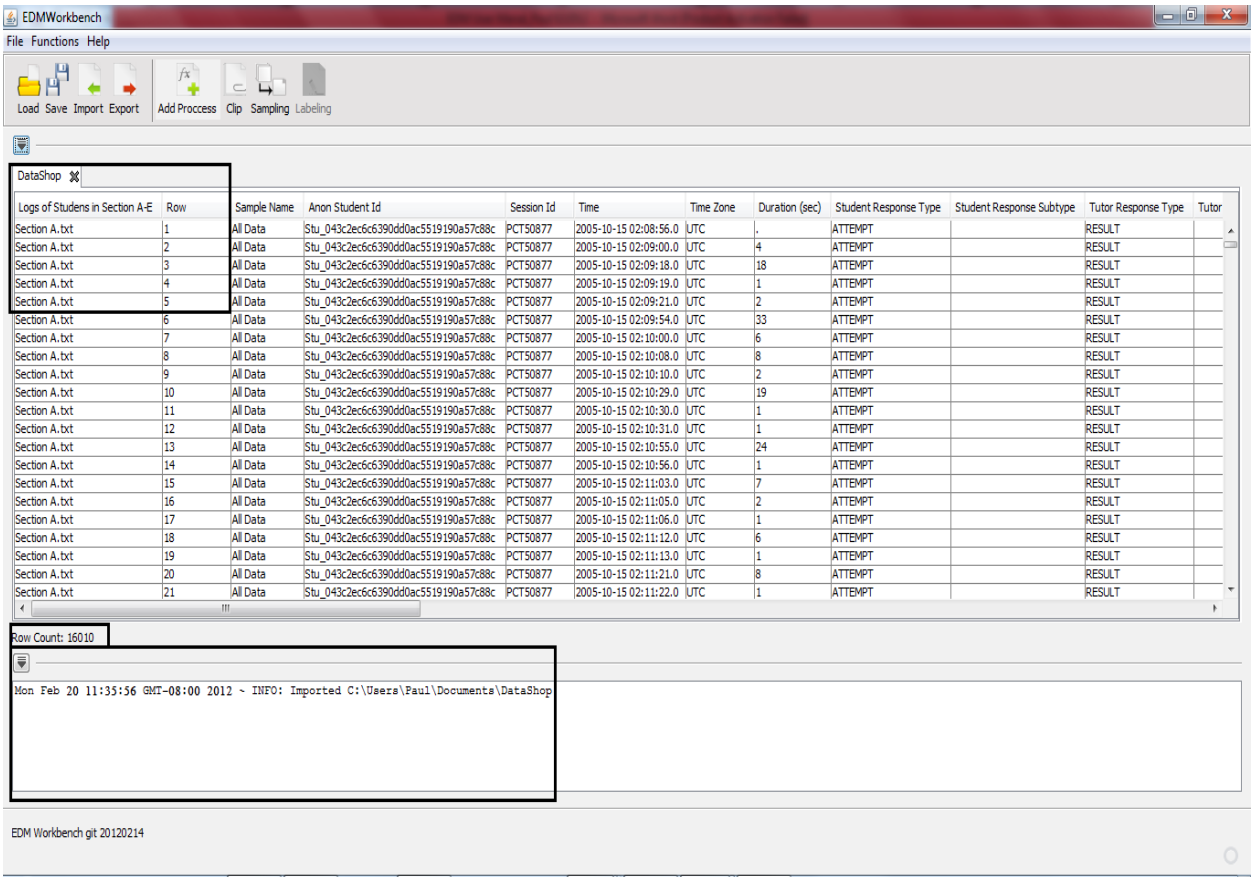


Figure 14: EDM sample Data Set

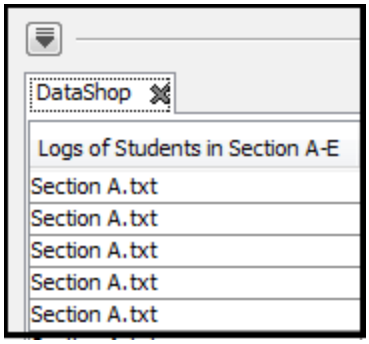


Figure 15: EDM Workbench Data Shop Tab

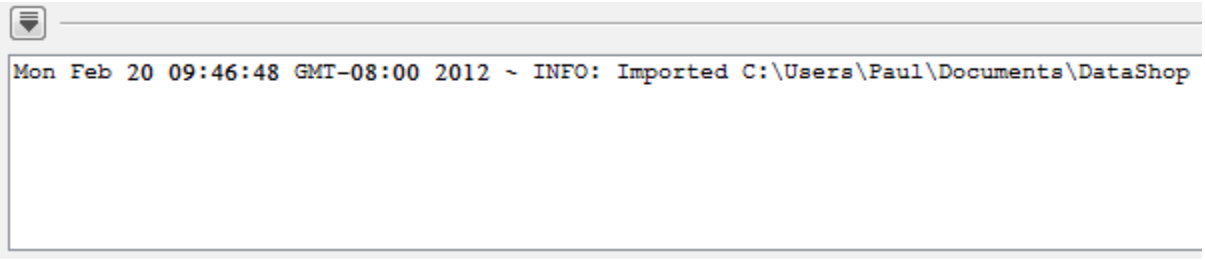


Figure 16: Status bar with timestamp and file directory

The **Status bar** displayed the information of the file imported together with the location **C:\User\Paul\Documents\Datashop** and the current time **Monday February 20 9:46 AM and 48 seconds**.

Clipping

The EDM Workbench allows the user to define the set of features by which the data should be grouped, so that clips do not contain rows from different groups. For example, if the data should be grouped by student, a single clip will contain data from only one student and not multiple students. The Workbench also specifies the clip size, either by time or by number of transactions. Delineation of clips by beginning and ending events is not yet possible, but is a feature planned for future implementation. The Workbench then generates the clips for analysis, according to a sampling scheme discussed in the next section

To clip the dataset, click Clip Button 

located either in the Function menu (Figure 7) or Toolbar (Figure 9). The system will then display a form with the column names (the basis for grouping e.g. group data with the same Logs of Student in Section A-E with the same Anon Student Id and with the same Time and so on). Clips can be divided by **Size**, **Time** or **Per Value Changed.**

Size as Clip

Type

By choosing **Size** as the **Clip Type**, the user will need to specify the desired number of transactions in a clip.

"*Complete Clips Only*" when checked, the system will only select clips where the number of logs is equal to the inputted clip size.

"*Allow Overlap*" when checked, the system will produce clips with overlapping logs. Given logs {1,2,3,4,5} and a clip size of 3, three clips will be produced: {1,2,3}, {2,3,4}, and {3,4,5}.

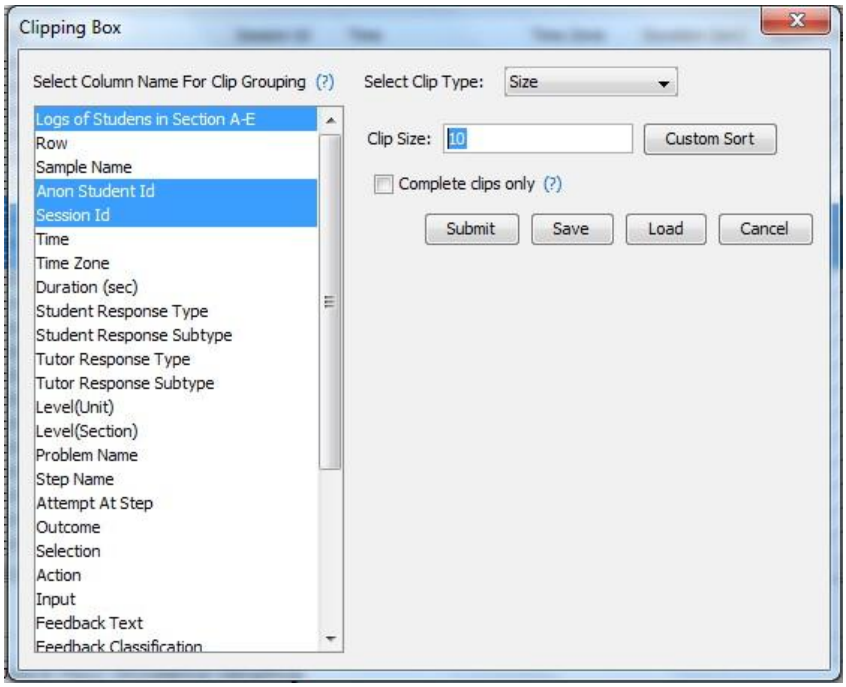


Figure 17: EDM Clipping Window

▪ Custom Sort Button

This allows the user to set how the transactions within a clip are ordered by sorting them according to criteria. **Add Level** Button adds another sorting criterion while **Delete Level** deletes the selected Row. Clicking the **Submit** button will implement the selected formatting properties.

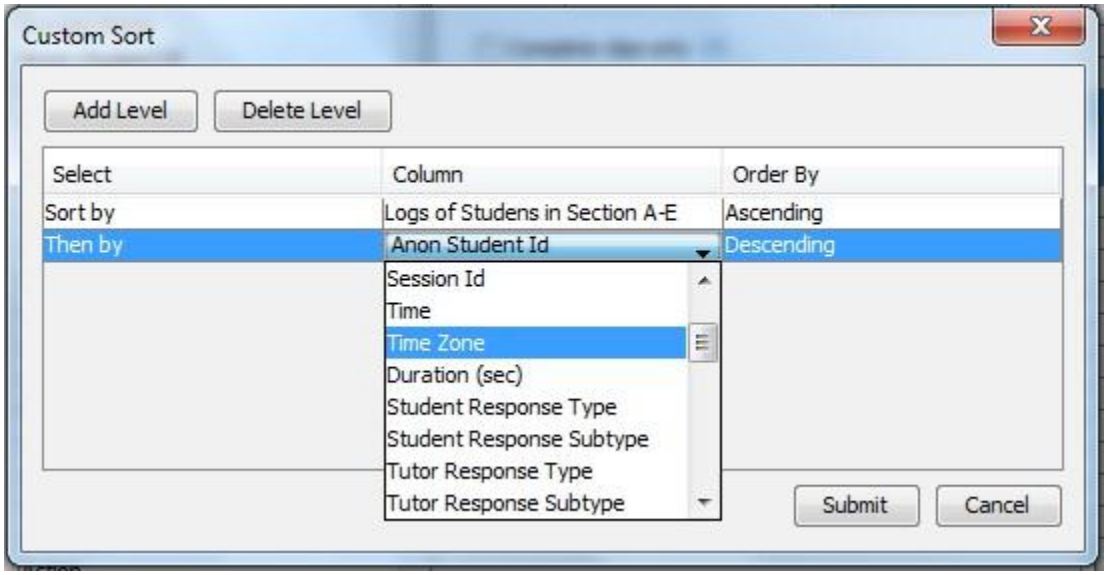


Figure 18: EDM Custom Sort

- ### Time as Clip

  By choosing **Time** as the **Clip Type**, the user will specify a time period per clip (e.g. 1 clip = 5 minutes interval). The column name with a time element (measured in seconds) must be specified. When done, click the submit button and double click the clips to view the inclusive logs.

- ### Per Value Change as Clip Type

  Per Value Change creates a new clip every time the value within the specified column changes.

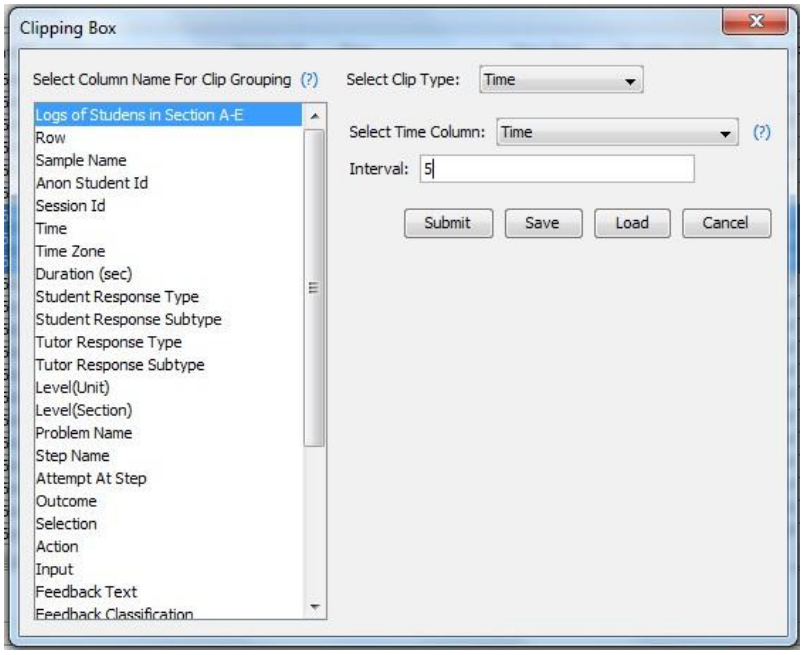


Figure 19: Window showing the Time as Clip Type

○ Cancel Button

This cancels clipping.

○ Save Button

The **Save** button saves the set properties applied in the Clipping Form. The user supplies a file name and clicks OK.

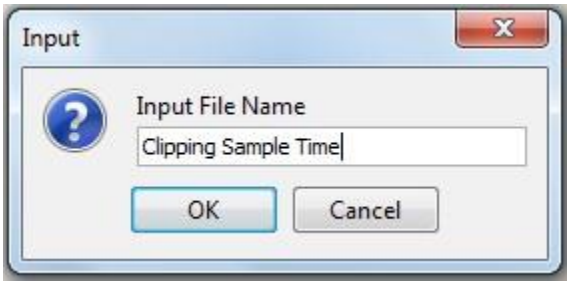


Figure 20: Save Dialogue

○ Load Button

Allows the user to select and load a previously-saved file from a drop-down list. (see Figure 22).

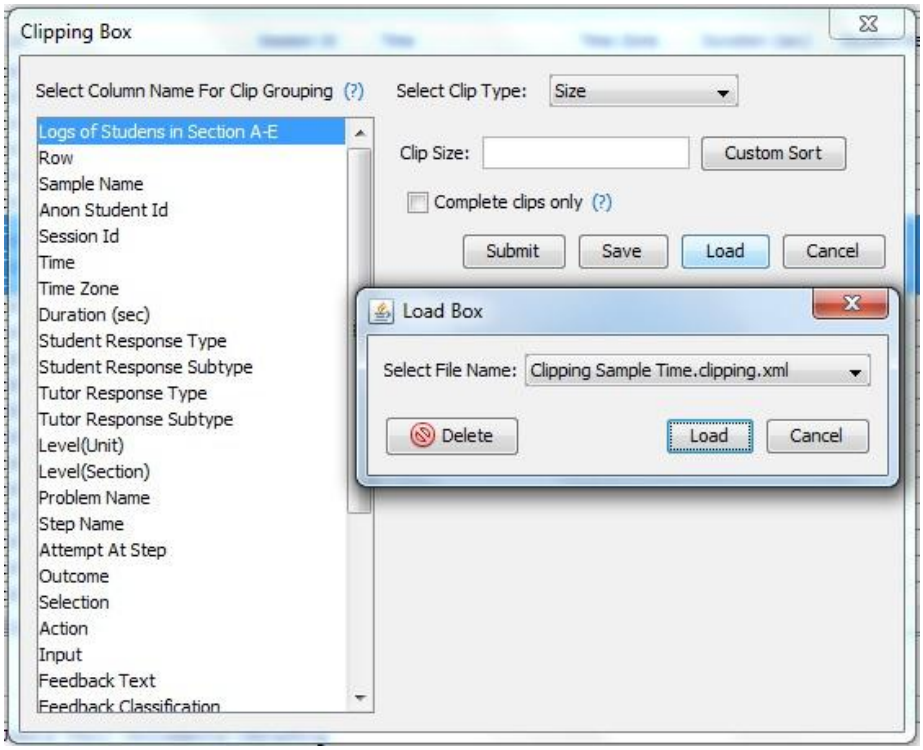


Figure 21: Load Window

Note: From the list of clipping.xml files, the selected template is Clipping Sample Time.clipping.xml

- **Submit Button**

  This closes the Clipping Form, clips the dataset from the current tab, and displays it with its properties set in a new tab. Double click a row to view the logs within it.

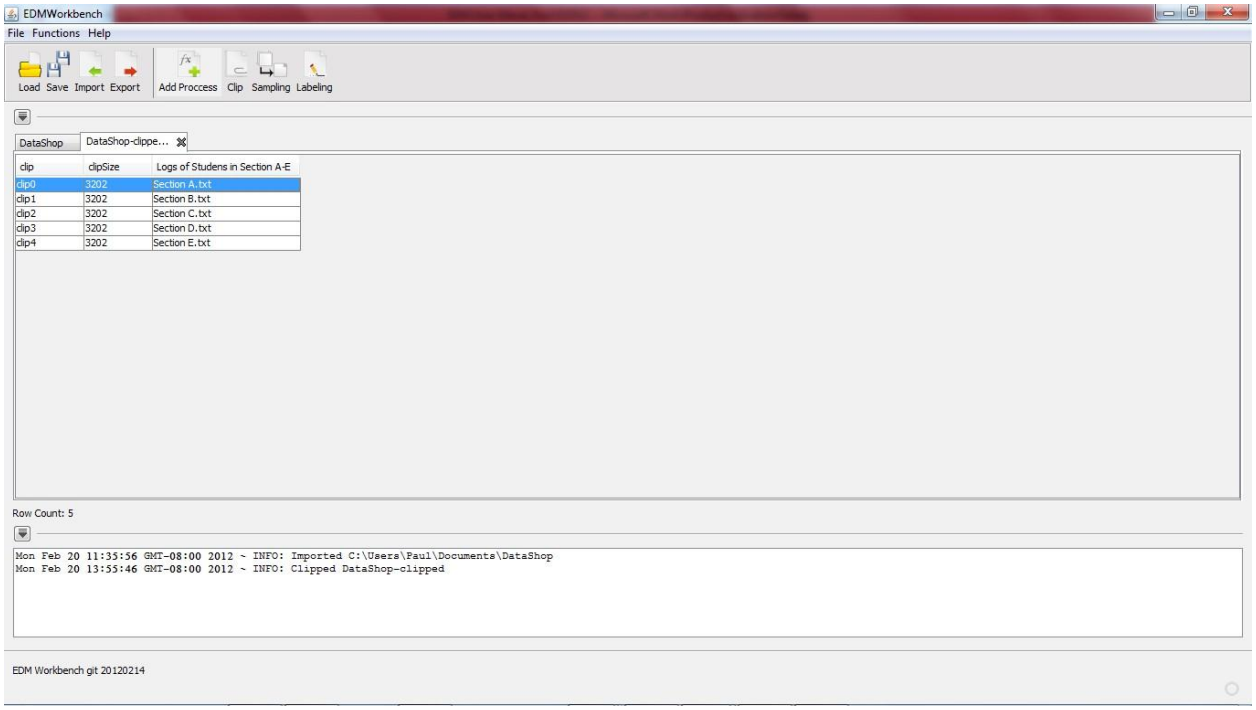


Figure 22: Clip submission

Note: Saving the clips upon closing the clipping tab will only save the clip-level rows. The associated transaction level rows are not saved.

Sampling

The data sampling feature of the Workbench allows the user to specify how clips are sampled from the data set. (It can also be used to sample at the action/transaction level). The user can specify the sample size, and whether the Workbench will randomly take the sample across the entire population or whether the workbench will stratify the sampling based on one or more variables.

Note that the Workbench allows the user to sample the data at any point of the process — after importing, after clipping, or after labelling – depending on the user's analytical goals.

To start sampling the dataset, click Sampling Button located either in the **Function** menu (Figure 7) or **Toolbar** (Figure 9). Sampling functionalities involve creating subsets from the dataset using automatic select and grouping options. A user may take samples or a subset from the loaded

dataset and save as a new dataset. Sampling can be stratified or random.

○ Random Sampling

To randomly select samples from a selected dataset:

Select Sampling Method > **Random**

Indicate the number of samples in the Sample Size textbox.

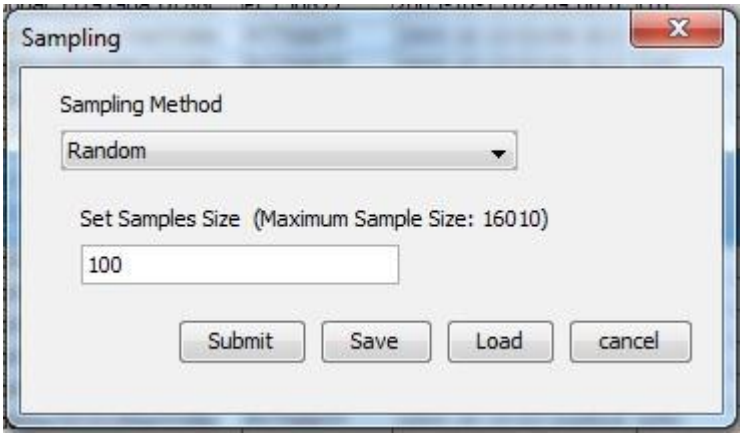


Figure 23: Sampling method selection

Note: The size inputted in the textbox should not exceed the indicated maximum sample size. If the user specifies a number greater than the maximum, the operation returns all the rows in the dataset.

○ Stratified Sampling

Stratified sampling randomly selects data from within specified subgroups to produce a stratified sample.

Select "Sampling Method" > **Stratified**

Set the number of samples in the Sample Size textbox

In the **Strata** list, click the column names that define the groupings. (Figure 25).

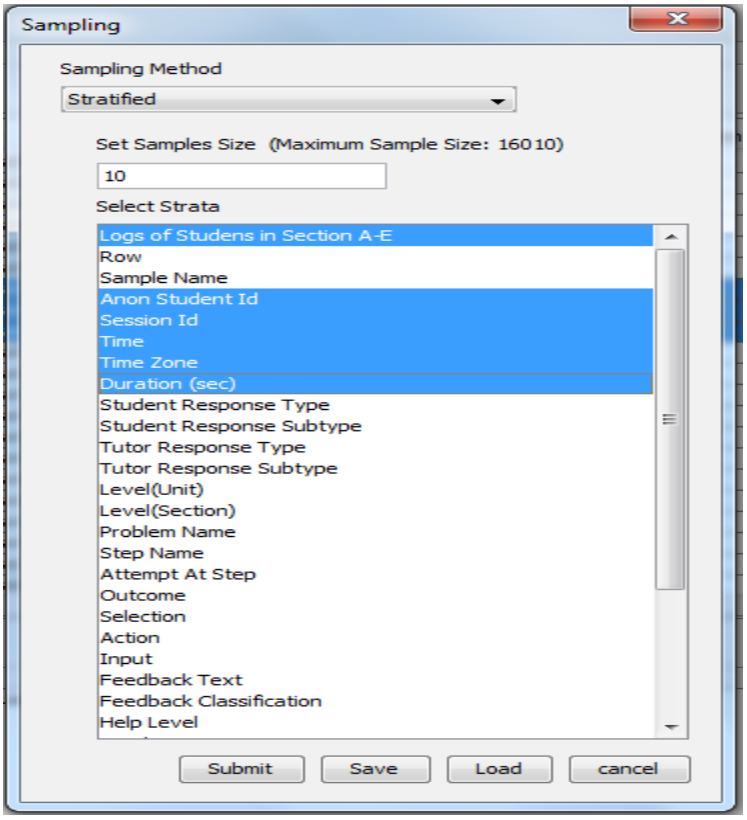


Figure 24: Strata selection

- ## Save Button

  Save Button saves the properties as a template.

- ## Load Button

  The Load button, allows the user to choose a previously-saved sampling template from a list and apply it to the current dataset.

Figure 25: Load Prompt

○ Submit Button

The submit button closes the Sampling Form, implements the sampling process and then displays the result in a new tab.

▪ Add Process

This allows the user to create a script composed of multiple processes and run them in a single thread.

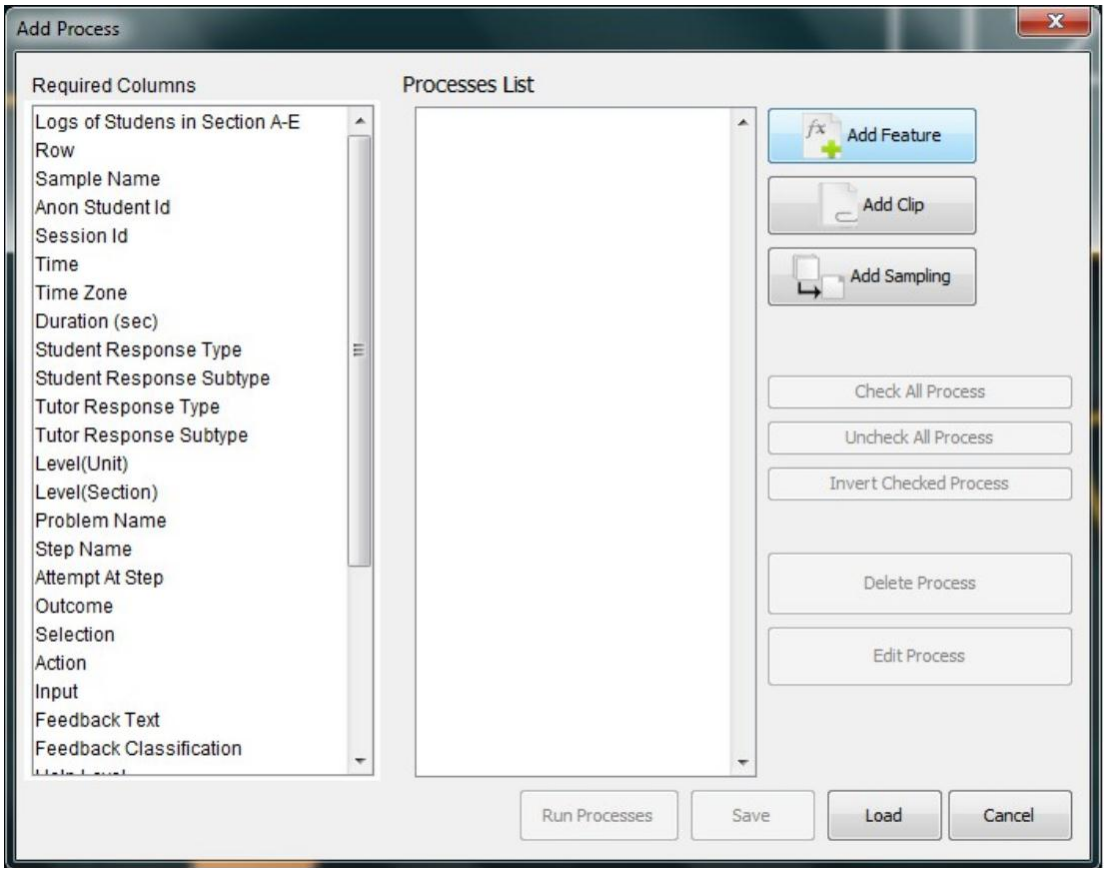


Figure 26: Feature selection window

○ Add Feature

This function allows users to add features to the dataset through the application of predefined operations

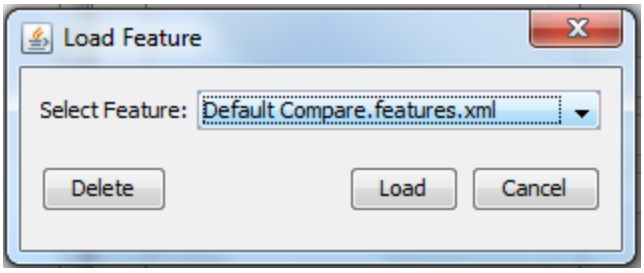


Figure 27: Load Feature Dialogue

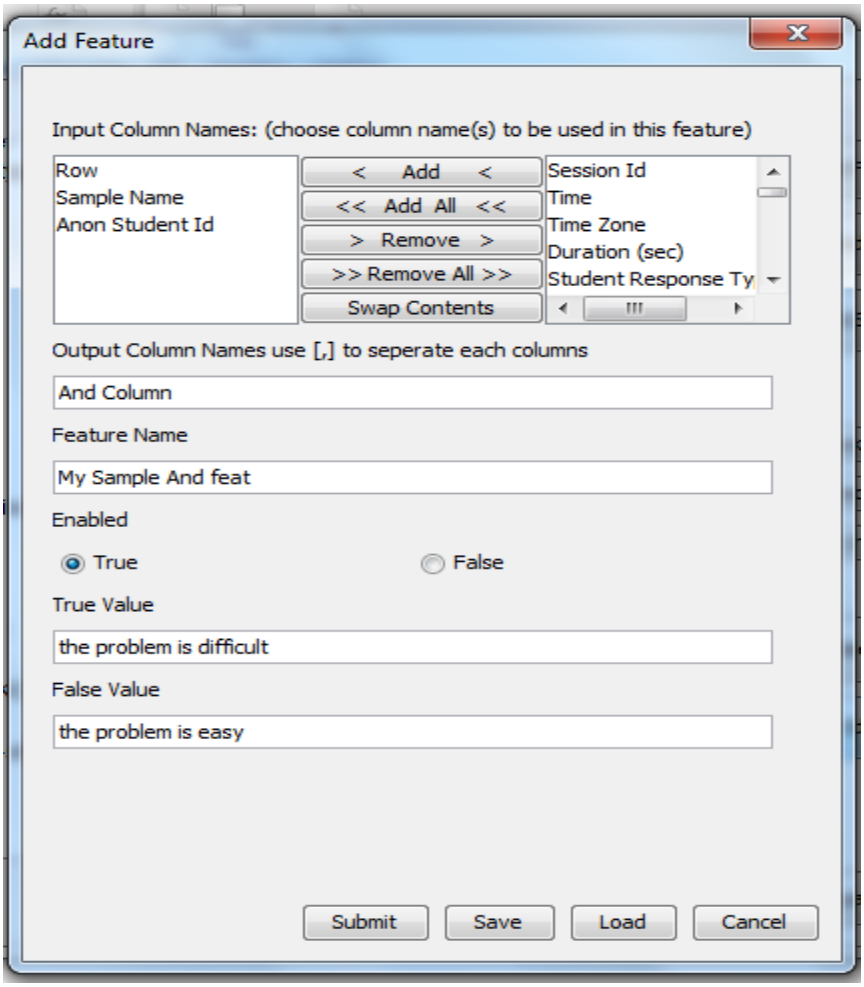


Figure 28: Add Feature window with sample "AND" feature selected

- ## Add Feature Buttons
  - ### Submit Button

    The submit button will execute the feature set by the user

- **Save Button**

  The save button will save the user selected properties to a file to allow the same values to be used again later.

- **Load Button**

  The load button allows the user to reload a template.

- **Cancel Button**

  This cancels the selected feature and removes it from the process list.

Add Feature Parameters

To add a new feature, the user will have to set several parameters. Depending on the operation that the user needs to perform, the user will have to supply a subset of the parameters listed below.

Input Column Names lists the selected values. The user can remove and/or add values to the columns.

Click one or multiple items and click **<Add<** to add the value(s) or click **<<Add All<<** to add all column name. Click **>Remove>** to delete one or multiple input column name or **>>Remove All>>** to remove all input column names.

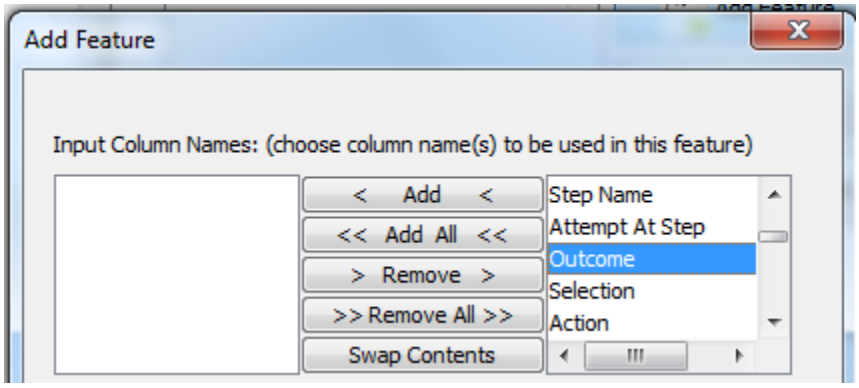


Figure 29: Sample add feature window

Output Column Names are columns are added later in the Datagrid after the user-selected values have been processed. These columns will also be included in the **Required Columns** in the **Add Process Window** (Figure 27)**.**

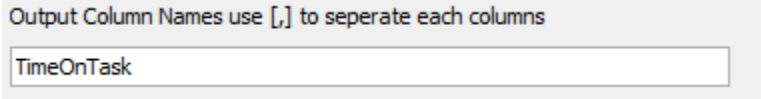


Figure 30: Selection of column names

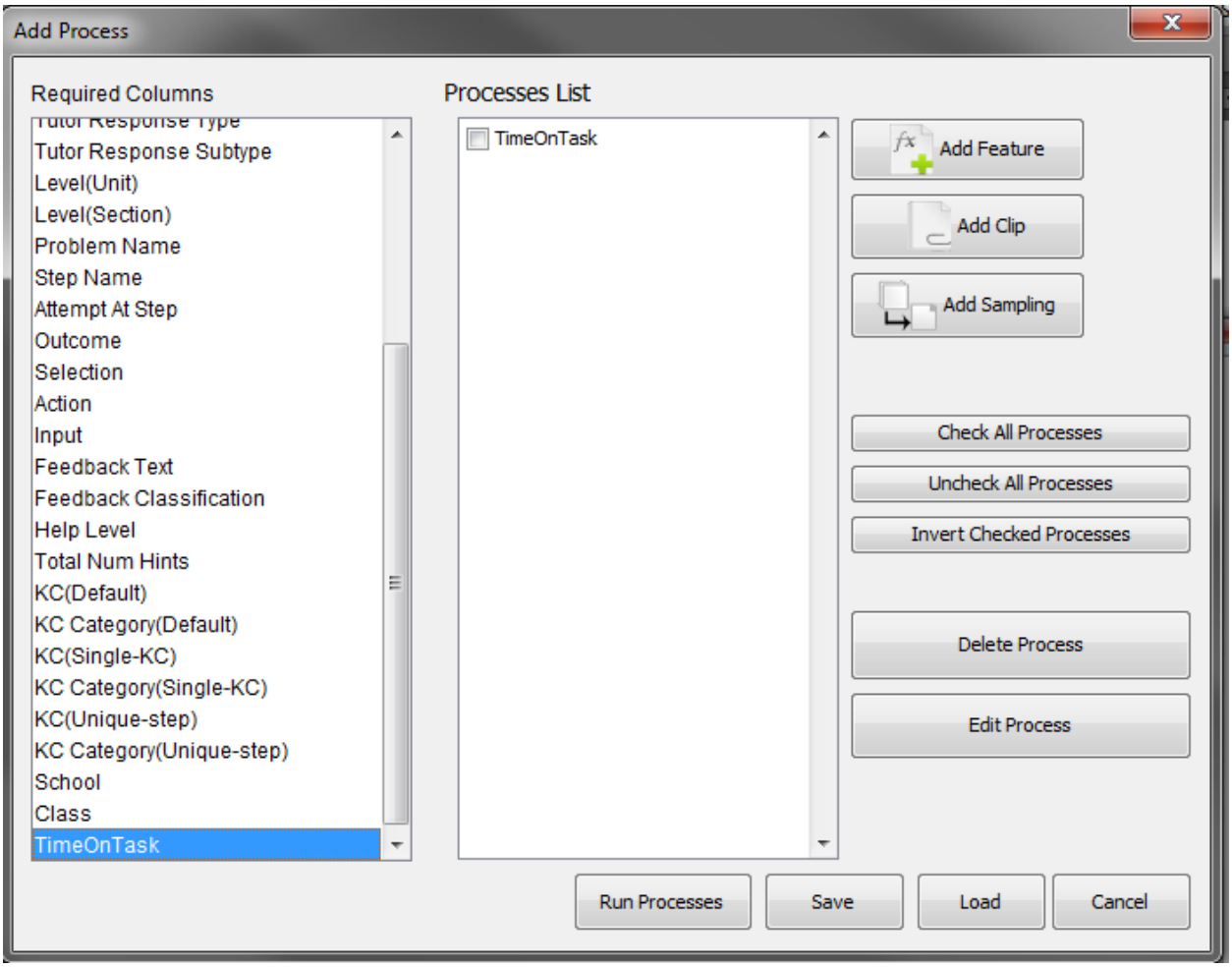


Figure 31: Add Feature Window with updated column

Feature Name is name to be displayed in the Process List (see Figure 30).

Enabled indicates whether to the selected feature will be used in the process or not. In Figure 29 the **Enabled** option was set to true. After submission, we now see that the feature is checked in the process list (see Figure 32).

True Value assigned to the result in the **Output Column Name** if operation returns a true. (see Figure 29).

False Value assigned to the result in the **Output Column Name** if operation returns a false. (see figure 29).

Check Value is the value to be compared against the **Selected Input Column Names**. This value can either be a string or integer depending on the feature used.

Operation Type contains values from 1-6 that correspond to different operations. Strings or integers can be compared in this feature.

- *Example:* Compare feature was the selected feature. The Check Value will be compared to the Selected Column Name and the output will depend on what operation selected below.

  1 - *Greater than* operation
  2 – *Greater than or Equal to* operation
  3 – *Less than* operation
  4 – *Less than or Equal to* operation
  5 – *Equal to* operation
  6 – *Starts with* operation

Date Column's value should be in the Date (Year-Month-Date) format.

Time Column's value should be in the Time (Hour:Minute:Second.) format.

Date/Time Column's value should be in the Date and Time (Year-Month-Date Hour:Minute:Second) format.

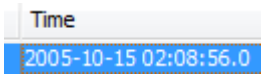


Figure 32: Time in (YYYY/MM/DD/HH/MM/SS)

All String checks if all the column values are strings, not numbers or any other type.

pKnowColumn's value should be the **pKnow** column. Calculate first the **pKnow** value using **pKnow** operation. Afterwards, use **pKnowDirect** with the **pKnow** value.

N[Numbers Only] if more elements in a group are found, only the last N items are kept for processing/start count every N rows??

Range Column **-** Range of values used for computation.

Group Column **-** Used for grouping rows with the same values for selected columns.

Sort Column **-** used for sorting the rows within the same group.

Problem Column **–** name of the column corresponding to the problem

Skill Column **–** name of the column specifying the skill

Outcome Column – name of the column used by certain features

Error Values - used to specify which values constitute an error for use by percentError.

L0[Number Only] – probability that the skill is already known before the first instance in using the skill in problem solving.

S[Number Only] – probability that the student will commit a fault if the skill was already known beforehand

G[Number Only] – probability that the student will deduce the correct answer given that skill is not known.

T[Number Only] - probability that the skill will be learned at each opportunity to use the skill, regardless whether the answer is correct or incorrect.

Attempt Column - Either of the two (depends on how it was used): "Is this the first attempt of the student to answer or get help on the problem step? ", or "How many attempts did they answer or ask for help on the problem step?"

- ## Add Feature List

As of V3.5, the system has 21 default operations available. Four parameters are common to all operations.

- Input Column Names
- Output Column Names
- Feature Name
- Enabled

Listed below are the current operations, their descriptions and parameters needed aside from the previously mentioned parameters.

Feature Name	*Description(s)*	*Other Parameters Needed*
1. AND	Executes a logical AND operation on the selection and returns the corresponding Boolean results.	- True Value - False Value
2. Compare	Compares if two values are identical. (Compare 1st selected Input Column Name with Check Values and its output is based on the Operation type used)	- Check Values - All Strings - Operation Type
3. Copy	Copy the values from a column (Values from Selected Input Column Name)	- None
4. CountIfLastN	Counts how many in the last n entries (including the current cell) are equal to a given value or values.	- Sort Columns - Group Columns - Range Columns - N[Numbers Only] - Check Values
5. CountLastN	Counts how many in the last n entries (including the current cell) are equal to the current cell.	- Sort Columns - Group Columns - Range Columns - N[Numbers Only]
6. Duration	Computes how many seconds the action took.	- Sort Columns - Group Columns - Date Column - Time Column - Date/Time Column
7. First Attempt	Determines if it is the first attempt.	- True Value - False Value - Group Columns - Date Column - Time Column - Date/Time Column
8. Inverse	Returns the inverse of a Boolean. If the column values equal the true value, return the false value instead and vice versa.	- True Value - False Value
9. ListUnique	Creates a new column with all the unique data from the selection.	- None
10. Maximum	Determines the maximum value in the selection provided.	- Sort Columns - Group Columns - Range Column
11. Mean	Computes the arithmetic mean of all the values in the selection.	- Sort Columns - Group Columns - Range Column

12. MeanCountIf	Computes the average number of entries that are equal to a given value or values, over all entries.	- Sort Columns - Group Columns - Range Column - Check Value
13. Minimum	Determines the minimum value in the selection provided.	- Sort Columns - Group Columns - Range Column
14. Or	Executes a logical OR operation and returns the corresponding Boolean results.	- True Value - False value
15. PercentError	Computes the percentage of past problems where errors were made on a skill.	- Sort Column - Group Colum - Problem Column - Skill Column - Outcome Column - Error Values
16. pKnow	Computes for the probability that the student knows the skill involved in an action.	- Sort Columns - Group Columns - Out Column - Check Values - L0[Numbers Only] - S[Numbers Only] - G[Numbers Only] - T[Numbers Only]
17. pKnowDirect	Checks if the current action is the student's first attempt on this problem step. If true, pknow-direct is equal to pknow; otherwise, pknow-direct is equal to -1.	- Attempt Column - pKnow Column - Check Value - False Value
18. RunningCountif	Computes the number of entries that are equal to a given value or values, up to the current cell, including the current cell.	- Sort Columns - Group Columns - Range Column - Check Value
19. RunningPrevCount	Computes the number of entries that are equal to the current cell, up to the cell before the current cell.	- Sort Columns - Group Columns - Range Column
20. StDev	Computes the standard deviation of a specified column.	- Sort Columns - Group Columns - Range Column

21. SumLastN	Computes the sum of the last n numbers in the selection specified.	- Sort Columns - Group Columns - Range Column - N[Numbers Only]
22. TimeSD	Computes time taken in terms of number of standard deviations from mean time.	- Sort Columns - Group Columns - Range Column

Submit Button will include the user-selected feature to the Process List.

Load Button will load available features.

Save Button will save the user-selected feature and add it to the directory of features for later use.

- ### Add Features in the Clip Level

  In the clip-level, there are 5 features which can be imposed on the clips: mean, max, min, stdev, and listUnique. These features' functionalities are similar to the ones above. Clipped dataset are composed of a parent container and a dataset representing each clip. Non-clip level operations will append output columns to each of the enclosed clips; however, a clip-level operation will append output columns only to the parent container.

- ### Add Clipping

  Allows user to set the desired clipping properties. The form applies the selected properties in the clipping form.

- ### Add Sampling

  Allows user to set desired sampling properties. The form applies the sampling properties set in the sampling form.

- ### Cancel Button

  Cancels and closes the Add Process form.

- ### Save Button

  The system shall save all the properties set in the Processes List which are then checked into a process.xml file.

- ### Load Button

  The system will load the all the configured processed list

(process.xml) files available in the process directory upon clicking the load button.

○ Run Process Button

The system runs all checked processes in the process list. The system will display information feedback in the Status Bar on what process it is currently taking and throws an error dialogue when the system encounters an error.

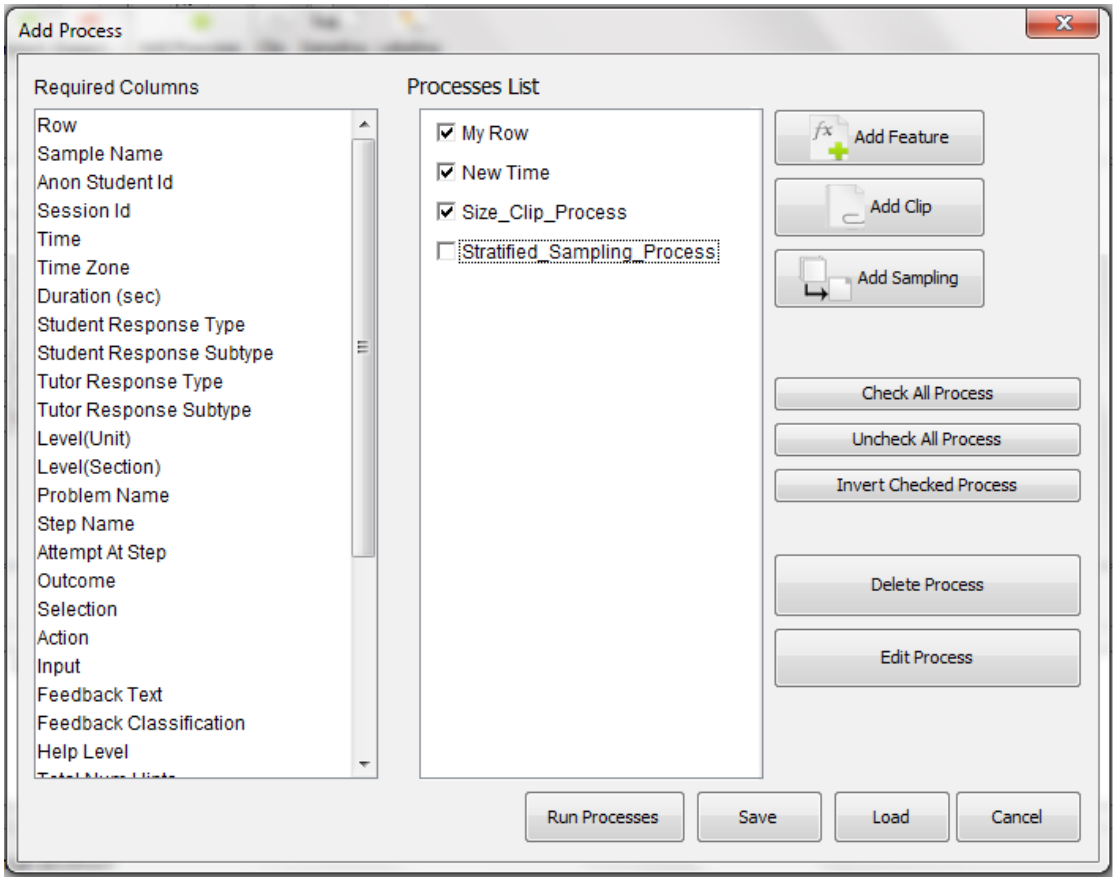
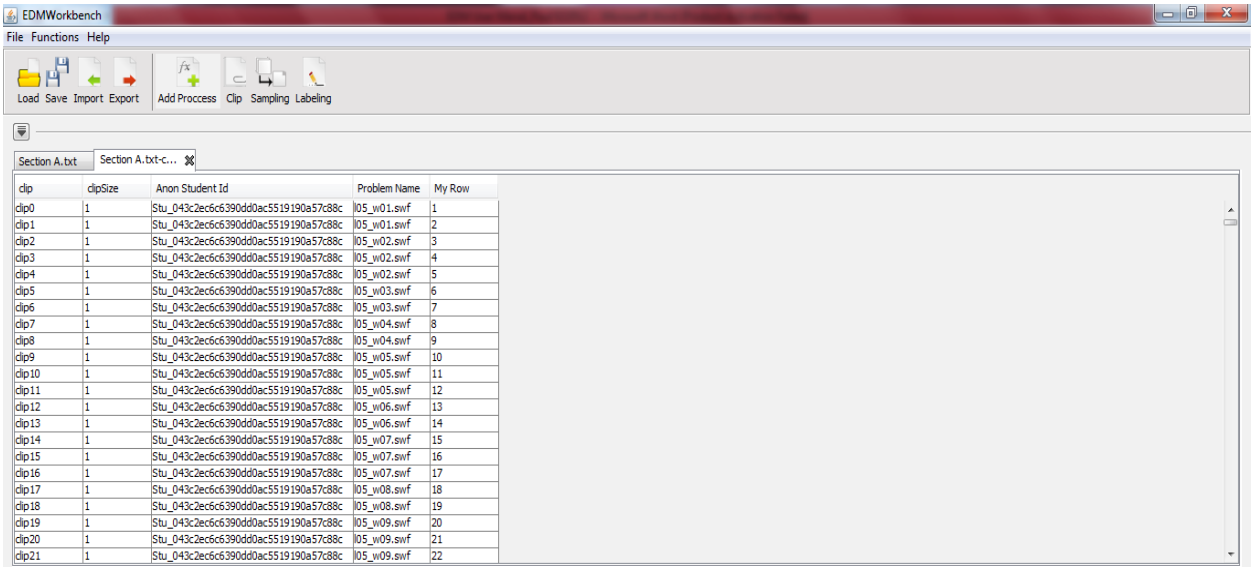


Figure 33: Sample System Process List



clip	clipSize	Anon Student Id	Problem Name	My Row
clip0	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w01.swf	1
clip1	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w01.swf	2
clip2	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w02.swf	3
clip3	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w02.swf	4
clip4	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w02.swf	5
clip5	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w03.swf	6
clip6	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w03.swf	7
clip7	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w04.swf	8
clip8	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w04.swf	9
clip9	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w05.swf	10
clip10	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w05.swf	11
clip11	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w05.swf	12
clip12	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w06.swf	13
clip13	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w06.swf	14
clip14	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w07.swf	15
clip15	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w07.swf	16
clip16	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w07.swf	17
clip17	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w08.swf	18
clip18	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w08.swf	19
clip19	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w09.swf	20
clip20	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w09.swf	21
clip21	1	Stu_043c2ec6c6390dd0ac5519190a57c88c	l05_w09.swf	22

Figure 34: Sample Clipping display

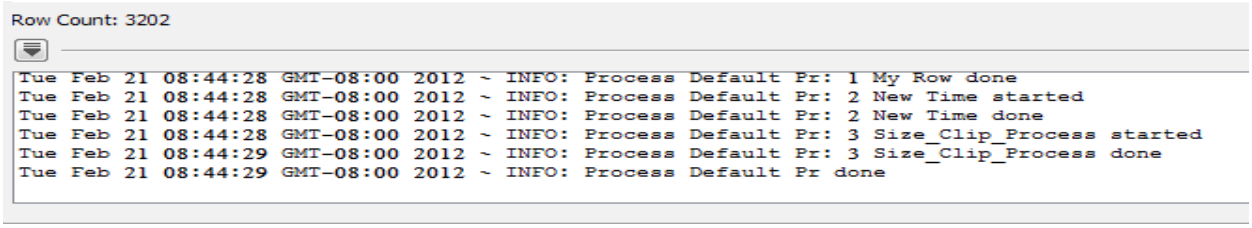


Figure 35: Clipping feedback

KC(Unique...	KC Catego...	School	Class	My Row	New Time
KC696		CMU		1	2005-10-15 ...
KC814		CMU		2	2005-10-15 ...
KC1592		CMU		3	2005-10-15 ...
KC238		CMU		4	2005-10-15 ...
KC1422		CMU		5	2005-10-15 ...
KC1415		CMU		6	2005-10-15 ...
KC1356		CMU		7	2005-10-15 ...
KC1329		CMU		8	2005-10-15 ...
KC75		CMU		9	2005-10-15 ...
KC496		CMU		10	2005-10-15 ...
KC8		CMU		11	2005-10-15 ...
KC1410		CMU		12	2005-10-15 ...
KC1547		CMU		13	2005-10-15 ...
KC1330		CMU		14	2005-10-15 ...
KC750		CMU		15	2005-10-15 ...
KC808		CMU		16	2005-10-15 ...
KC658		CMU		17	2005-10-15 ...
KC1397		CMU		18	2005-10-15 ...
KC668		CMU		19	2005-10-15 ...
KC742		CMU		20	2005-10-15 ...
KC1143		CMU		21	2005-10-15 ...

Figure 36: Sample distil features

Labelling

Labelling is an operation that is usually performed after clipping and sampling. During labelling, the user assigns ground-truth labels to clips of data.

The user first specifies a subset of the clip columns that should be displayed. The user also specifies the labels that the observer or expert will use to characterize each clip. The expert or observer will have to select between three labels: Confused, Not Confused, or Bad Clip. The circumstances under which an expert or observer labels a clip as "bad" changes depending on the data set, but typically indicate cases that should not

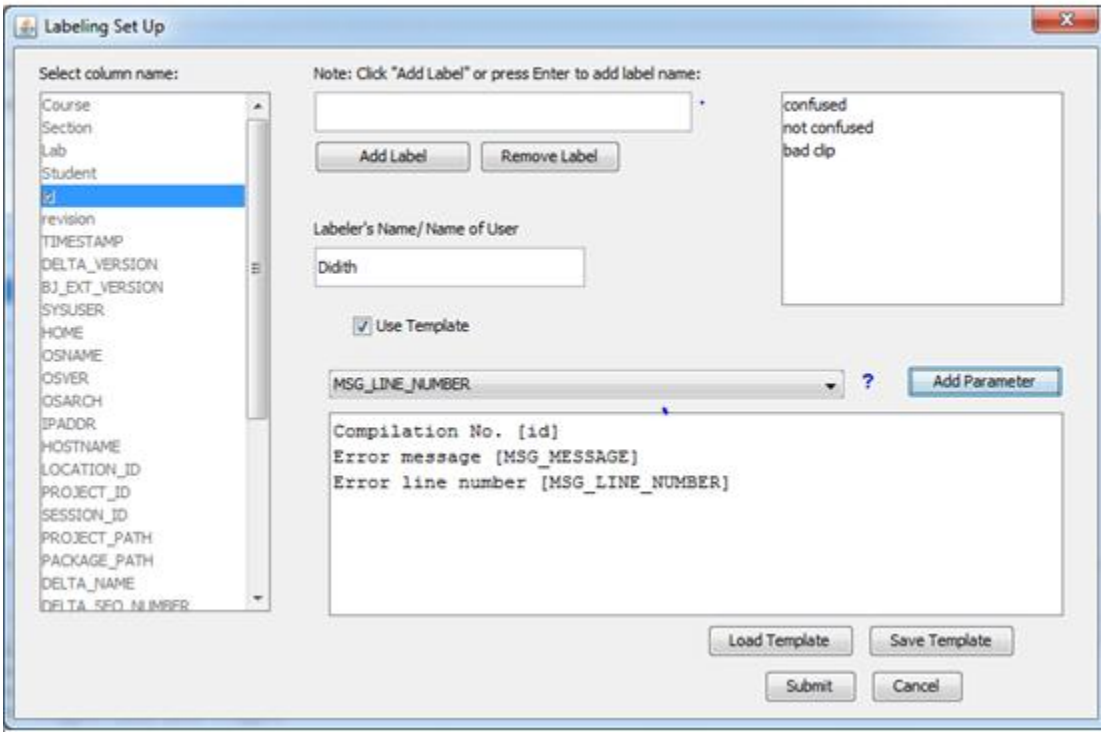


Figure 37: Labelling Window

A. Set-Up Labelling parameters

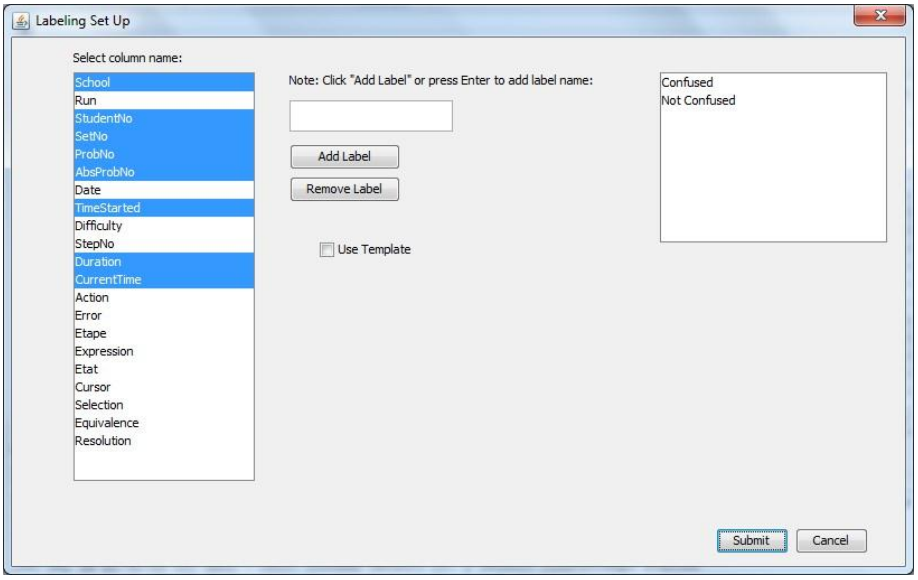


Figure 38: A sample Labelling window

1. **Label Textbox**
   Label Textbox is the top most textbox in the image above (Fig 37). User will need to input labels for the labelling process later. If the system reads a comma "," the texts next to it will be considered as different label from the previous text from the comma. Click Add Label to transfer the labels to the label list (the textbox to the right of the Label Textbox).

2. **Labeller's Name/ Name of User**
   Here, the user will need to input the user's name so that we can keep track to whom did the labelling of the dataset.

3. **Parameter/ Sentence Textbox**
   The textbox where the user can create sentences and choose parameters (enclosed with "[]") from the drop down menu (right above the textbox) that will change depending on the values of the row currently being labelled in the Labelling Process.

○ Use Template

The template area specifies a “pretty print” of the text replay. The user supplies descriptive text and indicates where the fields should be inserted

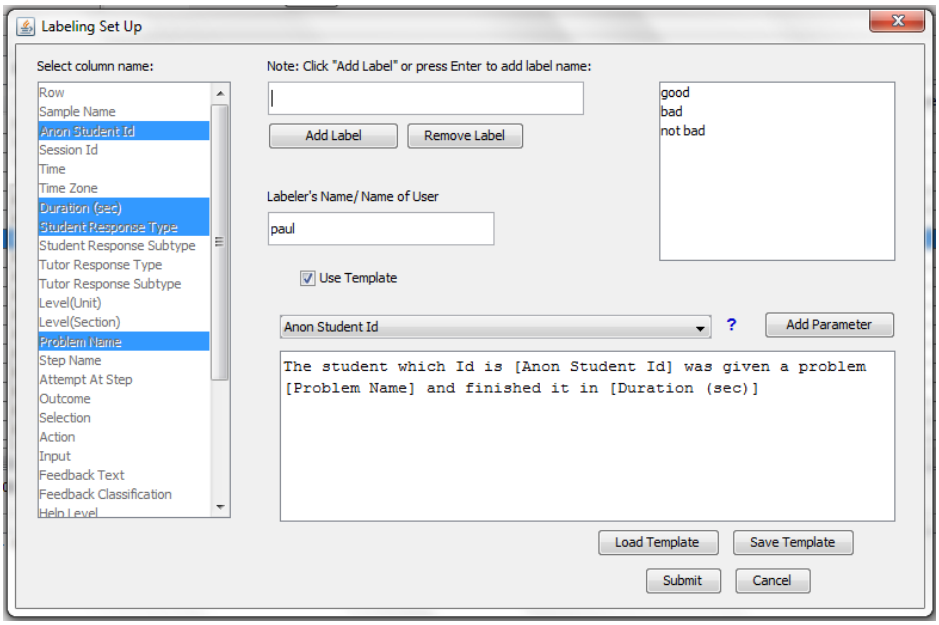


Figure39: Parameter Addition

Note: The system will automatically select the parameter in the “Select Column Name” list from the textbox.

▪ Set up Labelling Parameters

• Label Text Box

Label Textbox is the top most textbox in figure 39. The user will need to input labels for the labelling process later. If the system reads a comma “,” the string after the comma will be considered as a different label from the previous string before the comma. Click **Add Label** to transfer the labels to the label list (the textbox on the right of the Label Textbox).

• Labeller’s Name/User Name

Here, the user will need to input the user’s name in order to be able to keep track of the changes and who carried them out.

- ### Parameter and sentence textbox

  This is the textbox where the user can input sentences and choose parameters (enclosed with "[ ]") from the drop down menu (right above the textbox) that will depend on the values of the row currently being labelled.

Labelling Button

- ### Add Parameter Button

  In constructing sentences, users can manually input the parameters by enclosing it in a bracket "[]" and with the correct spelling or by selecting a parameter from the dropdown list and then clicking on the Add Parameter button to insert the selected parameter.

- ### Save Template

  The system allows the user to save the selected Labelling properties. A dialogue will be popped-up and will ask for a template name. The file will be saved as a Labelling.xml file.

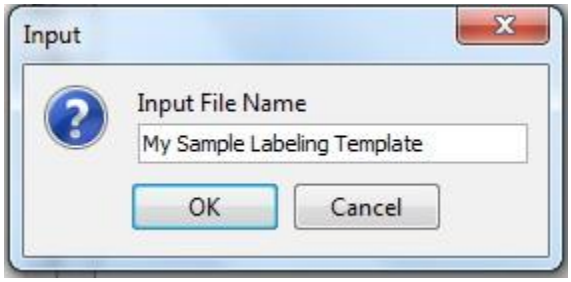


Figure 390: File Name input window

- ### Load Template

  The user may select a template from the list of labelling templates displayed by the system. The system will then load the properties of the selected template to the labelling form.

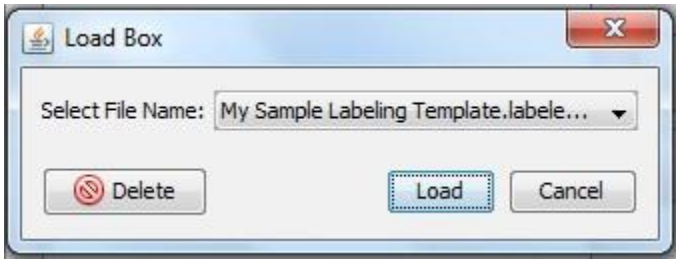


Figure 401: Labelling template loading window

B. Labelling the dataset

The Workbench then displays text replays of the clips together with the labeling options (Figure 3). A coder reads through the text replay and selects the label that best describes the clip. The labels are saved under a new column in the data set.

NOTE: Because a coder may have to label tens of thousands of clips [5], the coder may save his or her work and can continue the labelling process in a later session.

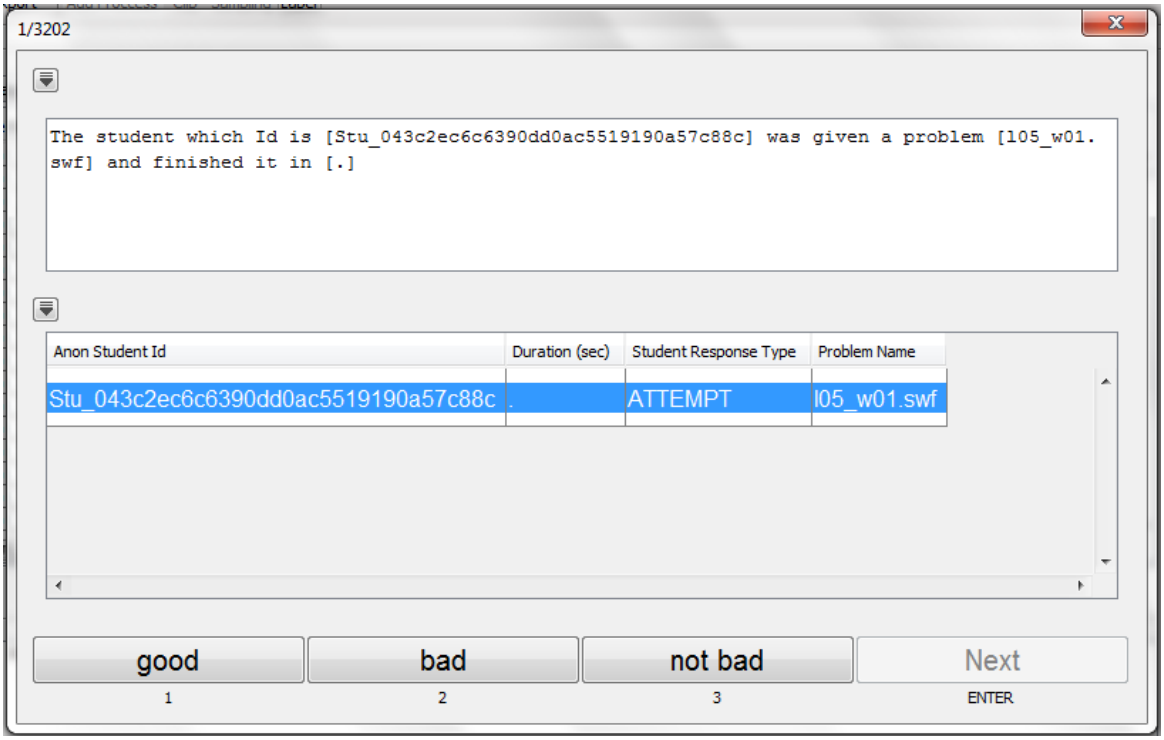


Figure 42: Dataset labelling window

Note: In the above example, the user can press the number keys 1,2 and ,3 as shortcut keys for the buttons “good, bad, and not bad” respectively. Press Enter to choose “Next” to go to the next row.

- ## Labelling Output

  As we can see in the figure 43 (below), the labels are shown with their corresponding timestamps and labeller. These column names are present for data organization.

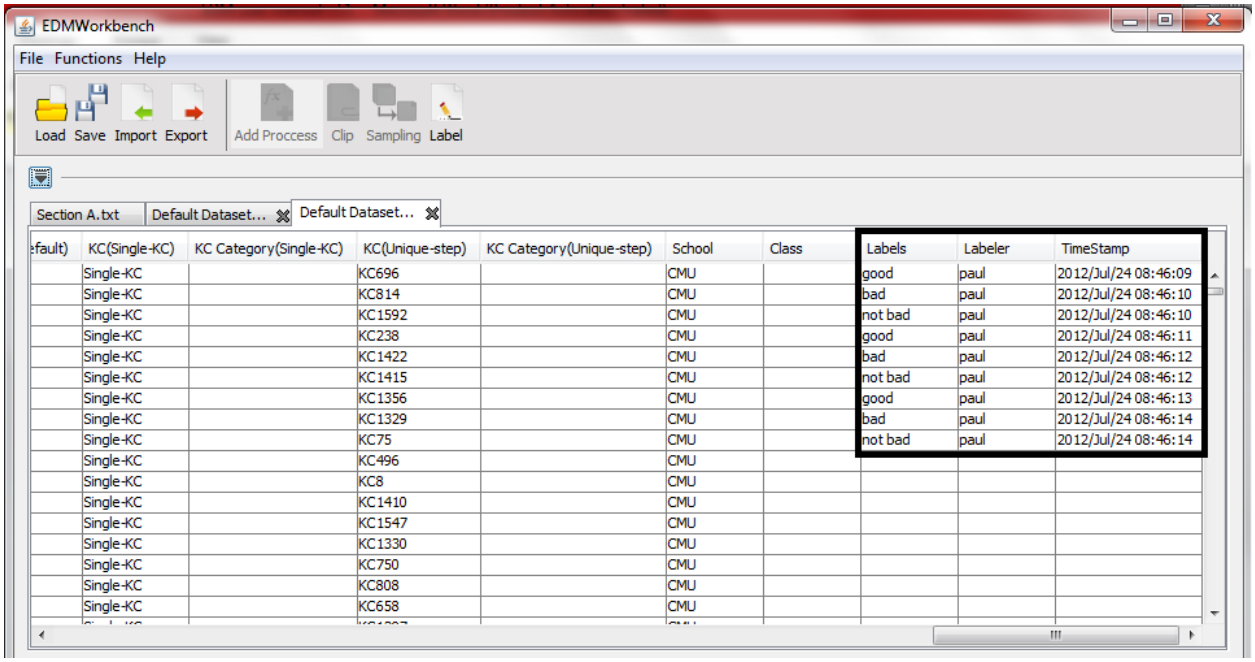


Figure 413: Sample labelling output

- ## Save

  Saves the dataset in the current tab by clicking the Save button located either in **File** menu (Figure 6) or **Toolbar** (Figure 9). The system will ask for the directory and then save it in zip format.

Note: Saving files will take time depending on the size of the dataset and speed of the computer.

- ## Load

  Loads EDM files by clicking the load button located either in the **File** menu (Figure 6) or **Toolbar** (Figure 9). Error dialogues will be displayed if any error is found with the specified directory or file.

  Note: The action button will be enabled depending on the file loaded.

- ## Export

  By clicking the export button located either in the **File** menu (Figure 6) or **Toolbar** (Figure 9), the system will save the current active tab into a .CSV file or into another specified format. Users must specify the directory in which the file will be saved.

  Note: Exporting a file will take time depending on the dataset's size.

Note:

In this version, we replaced the term the erroneous "feature" with the more correct "operation". We apologize for the confusion this has caused and are undertaking measures to correct these in the next version.

References

[1] Alcala-Fdez, J., Sanchez, L., Garcia, S., de Jesus, M.J., Ventura, S., Garrell, J. M., Otero, J., Romero, C., Bacardit, J. & Rivas, V.M. (2009). KEEL: A software tool to assess evolutionary algorithms for data mining problems. *Soft Computing: A Fusion of Foundations, Methodologies and Applications*, *13*(3), 307-318. (1)

[2] Baker, R.S.J.d. (2007). Modeling and Understanding Students' Off-Task Behavior in Intelligent Tutoring Systems. *Proceedings of ACM CHI 2007: Computer-Human Interaction*, 1059-1068. (3)

[3] Baker, R.S.J.d. & de Carvalho (2008). Labeling Student Behavior Faster and More Precisely with Text Replays. *1st International Conference on Educational Data Mining*, 38-47. *(5)*

[4] Corbett, A.T., & Anderson, J.R. (1995). Knowledge Tracing: Modeling the Acquisition of Procedural Knowledge. *User Modeling and User-Adapted Interaction, 4*, 253-278. (7)

[5] de Vicente, A., Pain, H. (2002). Informing the detection of the students' motivational state: an empirical study. *Proceedings of the 6th International Conference on Intelligent Tutoring Systems*, 933-943. (8)

[6] McLaren, B.M., Scheuer, O., & Mikšátko, J. (2010). Supporting collaborative learning and e-Discussions using artificial intelligence techniques. *International Journal of Artificial Intelligence in Education (IJAIED) 20*(1), 1-46. (11)

[7] Mierswa, I., Wurst, M., Klinkenberg, R., Scholz, M. & Euler, T. (2006). YALE: Rapid Prototyping for Complex Data Mining Tasks. In *Proc. of the 12th ACM SIGKDD Int'l Conference on Knowledge Discovery and Data Mining (KDD 2006)*, (pp. 935-940), ACM Press. (12)

[8] Walonoski, J. & Heffernan, N.T. (2006). Detection and Analysis of Off-Task Gaming Behavior in Intelligent Tutoring Systems. In Ikeda, Ashley & Chan (Eds.). *Proceedings of the 8th International Conference on Intelligent Tutoring Systems*. Springer-Verlag: Berlin. pp. 382-391. (14)

[9] Witten, I. H. & Frank, E. (2005). *Data Mining: Practical Machine Learning Tools and Techniques*, Second Edition, Morgan Kaufmann. (15)